Luperus scutellatus Jac. and *Malacosoma donkieri* (P. Z. S. 1897, pp. 568, 569).

The locality for both these species, which has been left out, is Madagascar.

Hemixantha piceipes Jac.

Fig. 6 in Plate xxi. of the P. Z. S. 1899 represents a variety of this species, not *H. terminata* as erroneously given.

Longitarsus africanus Jac. (P. Z. S. 1897, p. 555).

Of this species more specimens have kindly been sent by Mr. Marshall, which prove the insect to vary greatly in coloration; some of the specimens are piceous above, and others nearly black, with the apex of the elytra flavous; I may also add to my original description, that the last joint of the antennæ is in nearly every case fuscous.

Œdionychis natalensis Baly.

This species is identical with *Physodactyla africana* Dej.

Œdionychis rugicollis Jac.

Œdionychis africana Jac.: this species is an *Eutornus*, and the specific name must be altered to *clarki* on account of *Eutornus africanus* Clark.

Both these species, on account of their short and robust antennæ, should find their places in *Eutornus* Clark.

EXPLANATION OF PLATE XX.

Fig. 1. *Damia capitata*, p. 207.
2. ,, *frontalis*, p. 208.
3. *Peloptera apicata*, p. 210.
4. *Pseudocolaspis cupreofemorata*, p. 225.
5. *Scelodonta sexplagiata*, p. 226.
6. *Odontiomorpha minuta*, p. 239.
7. *Microhermesia hirticollis*, p. 220.
8. *Platyxantha bicincta*, p. 264.
9. *Monolepta exclamationis*, p. 258.
10. *Candezea centromaculata*, p. 261.
11. *Asbecesta ornata*, p. 255.
12. *Jamesonia femoralis*, p. 250.

March 20, 1900.

W. T. Blanford, Esq., LL.D., F.R.S., Vice-President, in the Chair.

Prof. Bell drew attention to a collection of Land-Planarians made by the Society's Corresponding Member, Dr. Goeldi of Para. These, like many other collections of Land-Planarians, had been confided for description to Prof. Graff, and some of them were the types of new species described by that author in his magnificent monograph. The collection before the Society had been sent to

W Purkis del et lith.

West, Newman imp.

AFRICAN PHYTOPHAGOUS COLEOPTERA.

Mr. Sclater with the request that he would deposit them in the British Museum. Prof. Bell stated that to the already good collection there they would be a valuable and welcome addition.

Mr. G. A. Boulenger, F.R.S., exhibited a specimen of *Polypterus lapradii* Steindachner, with large external gills, which had been recently brought home from the Senegal by M. P. Delhez. This fish measured 390 millimetres, and was therefore the largest on record in which this larval character had been retained. In connection with this interesting example, Mr. Boulenger also exhibited a full-grown female of the Common Newt (*Molge vulgaris*), from the environs of Vienna, bearing well-developed external gills.

Mr. S. L. Hinde read a series of field-notes on the Mammals which he had met with during five years' residence in East Africa, and illustrated them with lantern-slides from photographs of the animals taken in their native surroundings.

Mr. Hinde made the following preliminary remarks :—

The B. E. A. Protectorate, for the purpose of description, may be divided into two parts, the inhabited and the uninhabited. The inhabited ranges of hills are practically devoid of big game. The uninhabited country may be divided into two sections: regions of less than 3000 ft. above the sea-level, and regions more than 3000 ft. above the sea-level. The regions below 3000 ft. are, for the most part, densely covered with thorny jungle. The water-supply is small during the greater part of the year. In this dense jungle, eland, lesser kudu, oryx, impala, zebra, bushbuck, lions, and an occasional rhinoceros are to be found, but from the nature of the country and climate they are sufficiently protected from extermination by hunters without the necessity of legislation. Above 3000 ft. the game-country consists of rolling grass plains, interspersed in places with thin bush. In these plains the great herds of antelopes, zebras, &c. which now live and graze will soon be exterminated, unless the game-laws are enforced. One of the factors instrumental in aiding the escape of game is here absent. The ordinary hunter has to find his game, and this is often the most difficult part of the day's work. On large flat expanses the hunter can always see his quarry, and his whole time may therefore be given to stalking or killing it.

I should like to see animals from our Protectorate largely imported into the British Isles, and am convinced that they would both live and breed well in our parks, moors, and gardens, with little or no trouble about acclimatization. On the uplands of East Africa, the zebra, the white-bearded gnu, Coke's hartebeest, impala, waterbuck, Grant and Thomson's gazelles, the lesser reedbuck, and many other animals live in the open without any protection from the biting night-winds, rains, and intense heat. The temperature in the shade often varies from under 40° Fahrenheit at night, to over 80° in the daytime. During a very wet year at Fort Smith, in the Kikuyu district, waterbuck, Grant's and

Thomson's gazelles, and bushbucks lived healthily and well, though they were confined in the Fort Square, where for weeks together their feet and legs were never dry. Thomson's Gazelle bred for two generations in the Fort Square, and then all the animals died of rinderpest. This is a curious point, as none of these species suffer from rinderpest in their wild state.

From what I have seen of game, with the exception of elephant and rhinoceros, I am of opinion that they are not naturally timid. A railway train does not alarm the majority of animals, their curiosity at first draws them quite close to it; but within a few days of the establishment of a railway in a district, trains may pass noisily through a herd of game and few of them will even cease grazing. It would seem that animals, and antelopes in particular, are only afraid of what they have, in past experience, found to be dangerous. In most districts they have learnt that human beings represent danger, but in the country of the Masai, who do not hunt, the game take little or no notice of man. When horses were first brought to the country, in districts where game was constantly hunted, a mounted man could approach wild animals closely, but the moment he dismounted they fled. It is probable that antelopes only distinguish man under certain conditions; they apparently recognize him as an animal that walks erect, with a small head, and no neck or horns. In proof of this, it has been noticed that a man with a large load on his head can approach antelopes much nearer than a man without one; to their view, the man with the load, perhaps, seems to be a thick-necked animal whose head is out of all proportion to his body, and whom they have had no cause to fear. I have seen lions standing within 50 yards of a train, showing neither sign of fear nor intention of retreating, until the train pulled up and one or two men alighted. Seeing their well-known enemies close to them, the lions turned and trotted away.

The slides now exhibited are from photographs taken by me of animals in their natural surroundings. Those of the dead animals, with perhaps one exception, were taken without disturbing or arranging them in any way.

The following papers were read:—

1. On a Case of Homœosis in a Crustacean of the Genus *Asellus*—Antennule replaced by a Mandible. By W. Bateson, M.A., F.R.S., F.Z.S.

[Received March 20, 1900.]

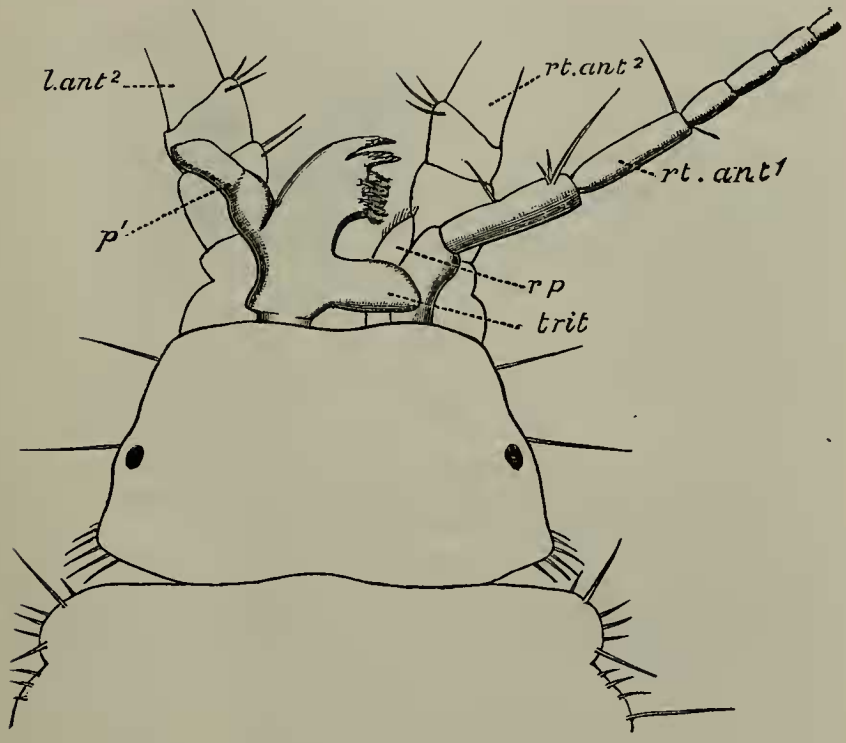
The subject of this note is a male specimen of *Asellus aquaticus* (an Isopod Crustacean) in which the left antennule is represented by a mandible.

The specimen was noticed when alive by Mr. J. J. Lister among

a number of *Aselli* taken from a large aquarium in the Cambridge Zoological Laboratory for examination by the students.

As the figure shows (fig. 1), the abnormal structure stands exactly as the left antennule should. Both antennæ and the right antennule are normal, as also are the mandibles, the other mouth-parts, and the rest of the body and its appendages, so far as they could be observed. The animal was of good size.

Fig. 1.



Head of *Asellus aquaticus*, seen from dorsal side.—*rt. ant.*[1], right antennule; *rt. ant.*[2], *l. ant.*[2], right and left antennæ; *rp*, palp of normal right mandible projecting from below; *p'*, palp of the abnormal mandible; *trit*, triturating process.

The abnormal appendage (fig. 2, p. 270) is a fairly well-formed mandible. The blade is complete, having two toothed processes and eleven plumose setæ. The latter are not quite regularly placed. The presence of *two* toothed processes proves that the appendage is a true *left* appendage, for the right mandible in *Asellus aquaticus* has only one toothed process, which bites between the two toothed processes of the left mandible [1].

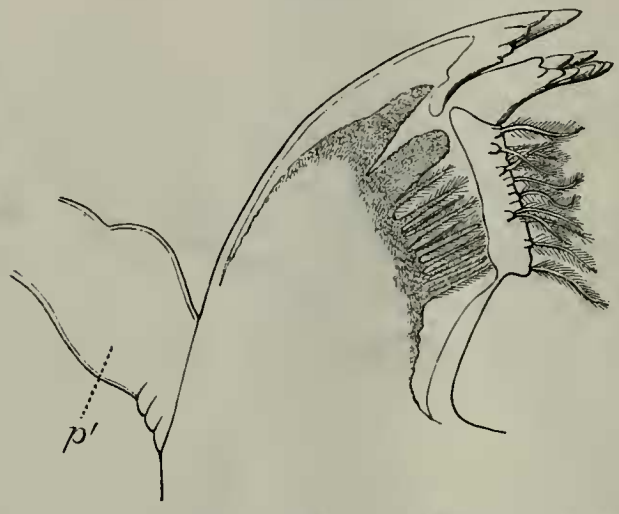
The teeth on these processes are more numerous and less regular than in a normal mandible.

[1] Sars, G. O., Crustacés d'Eau douce de Norvège, p. 97, pl. viii. fig. 26..

The palp is misshapen and rudimentary. It consists merely of an irregular process with slight traces of segmentation.

The molar process is rather less than the normal in length. Its triturating end is ill-formed, and does not bear the elaborate structures found in the same place in the normal mandible, the apex being simply covered with a thick plate of chitin.

Fig. 2.



Apex of extra mandible of *Asellus aquaticus*, to show details.
p', palp of abnormal mandible.

This mandible was in life carried flat to the body, as shown in the drawing, but I have not succeeded in determining which morphological surface was upwards. It is not evident which this should be, but presumably it is the face, which in the normal mandible is next the mouth. I regret that I could find no feature sufficiently differentiating the two surfaces; but from the fact that, as shown in the figure, the diminishing series of teeth are on the exposed surface, it seems likely that the presumption referred to is correct. In a normal mandible this series is much less clearly defined.

The animal was approaching a moult, and the newly-formed skin, which could be seen through, showed that at the next ecdysis the appendage would not be noticeably changed.

In the details of the toothing and in the number of the plumose setæ (11 instead of 13), the animal departs slightly from Sars's type; but on examining other specimens I find that these characters vary a good deal, as might be expected.

Elsewhere[1] I have discussed the significance of cases of this sort,

[1] Especially 'Materials for the Study of Variation,' Chap. v., where an account of previously recorded cases is given. To these should be added a case of an *Astacus* having a somewhat antennuliform structure with two jointed filaments replacing one of the eyes: Hofer, B., Verh. d. deutsch. zool. Ges. iv. 1894, p. 82, fig.

in which an organ takes on the likeness of another organ with which it is in serial homology.

This phenomenon, which I have called *Homœosis*, plays a considerable part in the variations of Meristic series. In plants such variations are common, but in animals instances so striking as that now under consideration are among the greatest rarities in nature. Among Arthropods probably not a dozen examples comparable with the present one are on record. The conversion of antennule into mandible has not hitherto been observed in any form.

It should be noticed that the homœosis in the present instance does not transform the appendage into the likeness of the appendage next to it in series, for this is the antenna. The change is to the next but one.

Perhaps the cases hitherto known which most nearly approach this one are those of *Cimbex* and *Bombus*, having the club of an antenna in each case replaced by a foot.

Since the discussion of these cases in 'Materials for the Study of Variation' was written, the new fact has been discovered by Herbst [1] that when the eye is amputated in *Palæmon* an antenna-like structure may be formed in its place on regeneration. The question therefore arises whether some other Arthropod cases of homœosis may not be similarly connected with regeneration. On this point there is little positive evidence. It may be noted, however, that Przibran[2], who made some experiments on the subject, found that in *Asellus* both pairs of antennæ were regenerated as antennæ.[3] The results of such experiments, however, are clearly very irregular. The regenerated part in Herbst's experiments was not always similar, and Przibran, on repeating Herbst's experiments, obtained only negative results. Here the matter at present rests.

2. On Echinoderms from Singapore and Malacca.

By F. P. Bedford, F.Z.S.

[Received March 8, 1900.]

(Plates XXI.–XXIV.)

The Echinoids and Asteroids described in this paper were collected during a residence of a little over a year in the neighbourhood of Singapore and Malacca by Mr. W. F. Lanchester and myself.

I am much indebted to the kind courtesy of the Hon. Sir J. A. Swettenham, Colonial Secretary of the Straits Settlements, and the Hon. W. Egerton, Resident-Councillor of Malacca, in allowing us to make use of the lighthouses under their jurisdiction as head-quarters for our work; and I am under a still greater obligation to

[1] Arch. f. Entwickelungsmech. ii., 1896, p. 544.

[2] Zool. Anz. xix. 1896, p. 424.

[3] P.S.—Since this paper was read Mr. L. Doncaster, of King's College, Cambridge, has repeated the experiment on *Asellus* with the same result.

Dr. R. Hanitsch, Curator of the Raffles Museum, for the great amount of trouble he took on our behalf, and for the readiness with which he placed his valuable experience of the local marine fauna at our disposal. I also wish to thank Mr. H. N. Ridley for his kind hospitality and advice.

Professor Bell has been good enough to allow me a room in the Natural History Museum, where I have had an opportunity of comparing our specimens with those in the National Collection; and Professor Minchin has kindly given me every facility for microscopical study at University College Laboratory.

From the point of view of the geographical distribution of the littoral fauna, this comparatively unworked district is a peculiarly interesting one: the sea rarely reaches a depth of more than 40 fathoms, and never, so far as I know, of more than 80, so that dredging from a small sailing-boat was always possible in calm weather; and although the collection of Echinoderms cannot be considered complete, yet I think specimens of all the commoner indigenous species have been collected either by ourselves or obtained from the natives.

Professor Bell has kindly looked through this paper and given me valuable suggestions.

I. ECHINOIDEA.

The region under consideration lies close to the Equator, between the Indian and Pacific Oceans, and might be regarded as a probable specific centre for many tropical forms whence migration took place in all directions—westwards to the Red Sea and East Coast of Africa; northwards to China and Japan; eastwards through the Pacific Islands towards the American Coast, and southwards in the direction of Australia and New Zealand. Plausible as such a view may appear *a priori*, the Echinoid evidence in its support is very meagre, and seems rather to point to a separate "centre" for each form-unit. The distribution of tropical Echinoids is as a rule very extensive: moreover, in the case of closely allied species their areas of distribution often overlap: *e. g.*, among Cidaridæ, *Rhabdocidaris annulifera* and *R. baculosa*; among Echinidæ, all the species of *Salmacis*; among Clypeastridæ, *Echinodiscus auritus* and *E. lævis*; and among Spatangidæ, *Lovenia elongata* and *L. subcarinata*. In these cases, where there are no geographical barriers we should expect perhaps a physiological isolation to manifest itself in differences of mode of life and habitat, but such does not seem by any means an invariable rule: *Laganum depressum* and *Laganum decagonale* were frequently dredged together, and must have been subjected to almost identical environmental conditions, and the same is true of *Salmacis globator* and *S. sulcata*.

Considering the limited area, the Echinoid fauna is a fairly large one. This is no doubt partially to be accounted for by the great variety exhibited by the inorganic environment: near the

mouths of the rivers extensive deposits of silt mixed with vegetable débris occur, and here, as a rule, the reef is poorly, if at all, represented; in places, however, where the reef is flourishing its distance from the shore is very variable, rarely exceeding 500 yards, and the lagoon shore is of the most varied description—mangrove-swamps, tracts of hard sand, or gravel may occur, or volcanic rocks may come down to the water's edge and, being eroded by the action of the sea, form tide-pools and crevices when the tide recedes.

Each kind of environment was found to have its own peculiar Echinoid fauna, each species except the most abundant being restricted to one sort of habitat in its adult condition; and in this connection it is worth noting that, although this is constant throughout the district, yet in other localities, *e. g.*, Batavia, the same species will be found in a different environment. A good instance of this is afforded by *Diadema saxatile*, which was the only reef-Echinoid of the district, and was a conspicuous object among the masses of coral on nearly all the reefs; whereas at Batavia this species was apparently found by Dr. Sluiter (*cf.* also Studer [1]) a short distance from coral on patches of sand, *Echinometra lucunter* being common among coral in that locality. It seems to me that, by a similar change of habitat, a certain amount of isolation might be caused which would enable variations in a direction favourable to that environment to become normal for the particular form-unit, and by a continuation of the process specific distinctions might become fixed. Without some such isolation it is difficult to imagine how any variations from the norm could become sufficiently stable to be perpetuated alongside of the type, or how any gradual modification could take place in the type itself [2], since the pelagic plutei that settle down in any given limited area can hardly be supposed to be the offspring of adults living within that same area, and there is no evidence, so far as I am aware, of discontinuous variation among Echinoids likely to lead to the formation of new races.

The species of which examples were obtained number sixteen, of which it may be worth remarking that four extend as far south as New Zealand; this is interesting in connection with the distribution of Asteroids and Holothurians, which appears to be much more limited.

Only a few Echinoids have been previously recorded from the locality, but of these there are two species which we have failed to find, and which are not represented in the Raffles Museum; they are *Salmacis dussumieri* and *Rhabdocidaris bispinosa*; there are specimens of the latter in the British Museum collected by Dr. Powell at Singapore, and I have satisfied myself of their distinctness from *Rhabdocidaris annulifera*. Only one new species is described, belonging to the morphologically interesting genus *Asthenosoma*, and we were fortunate in obtaining two young

[1] T. Studer, Monatsber. d. Ak. Wiss. Berlin, 1880, p. 868.
[2] *Cf.* A. E. Ortmann, Grundzüge d. mar. Tiergeographie, 1896, p. 31.

specimens which exhibit a number of points in the later development, and which I hope to describe in detail further on. The following is a list of the species of which examples were collected:—

1. *Rhabdocidaris annulifera* Lam.
2. *Diadema saxatile* Linn.
3. *Asthenosoma heteractis*, sp. nov.
4. *Temnopleurus toreumaticus* Ag.
5. *Temnopleurus reynaudi* Ag.?
6. *Salmacis sulcata* Ag.
7. *Salmacis globator* Bell.
8. *Salmacis rarispina* Ag. (fil.).
9. *Laganum depressum* de Blainv.
10. *Laganum decagonale* de Blainv.
11. *Laganum*, sp.
12. *Arachnoides placenta* Ag.
13. *Echinodiscus lævis* Ag. (fil.).
14. *Lovenia elongata* Gray.
15. *Metalia sternalis* Lam.
16. *Brissus carinatus* Gm.

1. Rhabdocidaris annulifera Lamarck. (Plate XXI. figs. 1 *a–d*.)

Cidarites annulifera, Lamarck, Hist. Nat. des Anim. sans Vert. t. iii. 1816, p. 57.

Phyllacanthus annulifera, Alex. Agassiz, Revision of Echini, pt. iii. 1872, p. 387.

Cidaris annulifera, P. de Loriol, Mém. Soc. Sc. Nat. Neuchâtel, t. iv. 1873, p. 25.

Cidaris lütkeni, P. de Loriol, Mém. Soc. Sc. Nat. Neuchâtel, t. iv. 1873, p. 29.

Schleinitzia crenularis, Th. Studer, Monatsb. Ak. Wiss. Berlin, 1880, p. 865.

Leiocidaris annulifera, L. Doederlein, Die Japanische Seeigel, i. 1887, p. 24.

References. H. Troschel, Sitzungsb. d. niederrhein. Ges. in Bonn, 1887, p. 335. Alexander Agassiz, 'Challenger' Reports, iii. Echinoidea (1881). P. de Loriol, Beiträge d. Geol. u. Pal. d. Libysche Wüste, Ab. 3, Hft. i., 1883. P. de Loriol, Mém. Soc. de Physique &c. de Genève, t. xxviii. No. 8 (1883). C. Ph. Sluiter, Natuurk. Tijd. v. Ned. Ind. D. xlviii. (1889). S. Lovén, Bih. till K. Sv. Vet.-Akad. Handl., Bd. 18 (1892). P. de Loriol, Rev. Suisse de Zool. t. i. (1893). R. Koehler, Mém. Soc. Zool. de France, t. viii. (1895).

Locality. Seven specimens from Singapore, one from Malacca.

Habitat. Spines of this species are extremely abundant in nearly all dredgings on a sandy or muddy bottom round Singapore; as Dr. Sluiter noticed in the Bay of Batavia, so here, the species seem to prefer a ground composed of comminuted fragments of shell,

coral, sand-grains, &c., but I have obtained it on the "tangles" from mud.

Distribution. The area of distribution is a somewhat anomalous one: it is fairly widely distributed over the Indo-Pacific circumtropical zone, extending from the Coromandel Coast on the west through the Bay of Bengal and Malay Archipelago to the Prince of Wales Is.: in the east and southwards it extends into the Antarctic littoral zone, having been found in Tasmania as well as on the South-Australian coast, but it is not reported from as far north as Hongkong or the S. Japanese seas.

There seems little doubt that M. de Loriol is right in associating Studer's *Schleinitzia crenularis* from New Guinea with this species. Prof. Troschel and others have shown the inconstancy which the tubercles exhibit with regard to absence or presence of crenulation among recent Cidaridæ; and I have followed M. de Loriol (*loc. cit.* 1883, p. 1) in uniting Agassiz's species of *Phyllacanthus* and *Stephanocidaris bispinosa* in Desor's genus *Rhabdocidaris*.

The specimens brought home represent a series showing growth-changes from an individual 8 mm. in diameter to one 57 mm. in diameter. Considerable allowance has to be made for individual variations in drawing deductions from so few specimens; but it seems worth while to give a table of the principal measurements and also to figure the changes taking place in the spines during growth.

As is well known, new coronal plates are formed between the calycinals and the corona, the first-formed appearing as minute sectors between the oculars and genitals (*cf.* condition in *Asthenosoma*); and Prof. Lovén has described the process of formation of the perignathic girdle and peristomal radial and interradial plates by absorption from the coronal plates and redeposition on the buccal membrane. In this species, unlike *Dorocidaris papillata* examined by him, the peristomal plates do not increase in number after the animal has reached a diameter of 22 mm.; and judging from the relative positions of the plates and spines of the corona bordering on the peristome, I conclude that no entire coronal plates have been absorbed in that region subsequent to the stage represented by the smallest of our specimens (8 mm. in diameter). The formation of new coronal plates probably continues throughout life, and the spines evidently increase in length up to a quite late stage; but whether they keep pace with the growth of the test is not certain, as in the largest specimen they had apparently been injured during life. When first formed, the spines are always smooth and acquire the characteristic granulations and thorns later; but it is interesting to note that in the smaller specimens the spines acquire the typical characteristics long before they reach a length at which granulation begins to appear in the spines of larger individuals (*cf.* Plate XXI. figs. 1 *b*, 1 *d*). In some specimens all the tubercles are smooth, while in others many of the larger tubercles are very

TABLE OF MEASUREMENTS OF *RHABDOCIDARIS ANNULIFERA*.

Specimen.	Diam.	Height.	Interambulacral Spines. 1st	2nd	3rd	4th	5th	6th	7th	8th	9th	Breadth of Ambulacrum at Equator.	Breadth of 1 A. at Equator.	Diameter of Calycinal Area.	No. of Peristomal Plates.
No. 1 ...	8	5	1·5 / 2·0	3·5 / 6·0	7·5 / 10·0	13·5 / 3·5	abs	abs	abs	abs	abs	1·0	3·0	4	
2 ...	10·5	5·5	2·0 / 2·5	3·0 / 4·5	4·0 / 5·5	9·0 / 11·0	14·0 / 5·5	abs	abs	abs	abs	1·75	4·5	4·5	
3 ...	11·5	6·5	2·5 / 3·0	5·0 / 6·5	8·5 / 7·5	12·0 / 14·5	15·5 / 0·5	abs	abs	abs	abs	2·0	5·5	4·5	5
4 ...	14	9	2·5 / 3·0	4·0 / 4·0	8·0 / 8·5	9·0 / 17·5	25·5 / 16·0	1·0 / abs	abs	abs	abs	2·0	6·0	6·5	6, 5 ?
5 ...	22	13	3·5 / 4·5	5·0 / 8·0	8·0 / 11·5	12·5 / 24·5	31·0 / 36·0	35·5 / 6·0	0·5 / abs	abs	abs	3·0	10·5	10·5	8, 7
6 ...	25·5	14	6·0 / 6·5	8·0 / 8·5	8·5 / 19·0	25·0 / 31·5	42·5 / 50·0	33·5 / 4·0	abs	abs	abs	4·0	12·5	11·0	8, 7
7 ...	40	29	Longest spine 59 mm.												
8 ...	57	37	Longest spine 59 mm.												

No. 1. Longest spine = 1·7 × Diameter.
2. „ = 1·3 × „
3. „ = 1·3 × „
4. „ = 1·8 × „

No. 5. Longest spine = 1·6 × Diameter.
6. „ = 1·9 × „
7. „ = 1·5 × „
8. „ = 1·0 × „

All linear measurements in millimetres.

distinctly crenulated in their aboral half, as noticed by other observers; and, as pointed out by them, it is of interest in connection with the fossil species of the genus, e. g. *Rhabdocidaris nobilis* Desor, found in the Upper Jurassic strata of Europe.

2. Diadema saxatile Linn. (sp.).

For synonymy, *vide* S. Lovén, Bihang till Kongl. Sv. Vet.-Akad. Handl. Bd. xiii. Afd. 4, No. 5 (1887).

References. Th. Studer, Monatsber. d. k. Ak. Wiss. Berlin, Oct. 1880, p. 868. P. de Loriol, Mém. de la Soc. de Phys. &c. de Genève, t. xxviii. No. 8, 1883, p. 13. P. & F. Sarasin, Ergeb. naturw. Forsch. Ceylon, Bd. i. Hft. 1, 1887. C. Ph. Sluiter, Natuurk. Tijd. v. Ned. Ind. D. xlviii. 1889, pp. 285, 288. G. W. Field, Johns Hopkins Univ. Circ. vol. xi. No. 97 (1892).

Locality. Singapore and neighbouring islets.

Habitat. This species is abundant on the reefs wherever the coral is flourishing. In the daytime several individuals may often be seen congregating together under the shadow of projecting platforms of *Madrepora*, *Turbinaria*, or other coral. Unlike Drs. Sluiter and Studer, I have never observed it except in the immediate vicinity of living coral and usually on the outer edge of the reef (*cf.* Field). As the Drs. Sarasin point out, it is an extremely unpleasant creature to handle owing to the sharpness of its spines, the tips of which break off in the flesh, and when any attempt is made to hold it, it generally retreats to a place of greater security; when in its natural surroundings I have never noticed any indications of attack or defence unless touched. So far as I know, it is the only Echinoid which is used as an article of food by the Malays of the "Straits."

Distribution. The distribution is an extremely wide one throughout both the Atlantic and Indo-Pacific circumtropical zones; in the north it reaches up to Japan, the Mediterranean, and the Canary Is., and it has been found as far south as the Cape of Good Hope and N.E. Australia, but I cannot find any record of its occurrence from the west coast of America. The species is extremely variable both in form and colouring, but the varieties do not seem to be confined to separate localities.

In one young specimen the spines, as described by other observers, are banded with purple and white, the test being purplish black as in adult.

The coloration of this species is subject to a very considerable amount of modification, but whether there is really more than one species living in the district I am unable to state positively. The same uncertainty exists in my mind as to the Asteroid *Pentaceros* described later in this paper, and it would require a random selection of a large number of examples in order to settle the question.

3. Asthenosoma heteractis, sp. nov. (Plate XXI. fig. 2.)

References. Grube, 45es Jahresb. d. Schles. Gesell. f. vat. Cult. 1863 (*A. varium*). H. Ludwig, Zeitschr. f. wiss. Zool. Bd. 34, 1880, p. 70 (*A. varium*). A. Agassiz, 'Challenger' Reports, vol. iii. Echinoidea, 1880, p. 82 (*A. grubei*). P. & F. Sarasin, Ergeb. naturw. Forsch. Ceylon, Bd. i. Heft 3, 1888 (*A. urens*). S. Lovén, Bih. till K. Sv. Vet.-Ak. Handl. Bd. 18, 1892 (*A. varium*). F. J. Bell, Ann. & Mag. Nat. Hist. (6) vol. iv. 1889, pp. 436–438. P. de Loriol, Rev. Suisse de Zool. t. i. & iii. 1893 & 1896 (*A. varium*). S. Yoshiwara, Ann. Zool. Jap. vol. i. part 1, 1897 (*A. ijimai*). R. Koehler, Zool. Anz. xx. 1897, p. 307.

Locality & Habitat. This species occurs in some numbers in about 5 fathoms of water on a muddy bottom off the west of Pulo Brani, Singapore; a single specimen was dredged by Dr. Hanitsch in the New Harbour, Singapore; it lives in company with a species of *Haplodactyla*, specimens being frequently obtained together in the dredge.

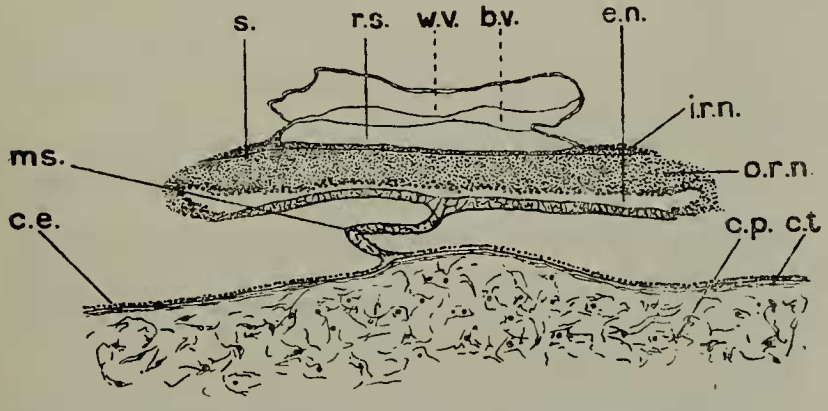
This form is very closely allied to the other three shallow-water species of *Asthenosoma*; its adult characters appear to be very constant, and although its differences from these species are very slight, it seems advisable to regard it as a distinct species. The nearest ally is perhaps *Asthenosoma urens*, collected by the Drs. Sarasin in the north of Ceylon, which it resembles in the possession of thorn-bearing spines in the neighbourhood of the ambitus, as well as poison-organs arranged along each side of the interambulacral space, and in the former respect it differs at once from *A. varium* and *A. grubei*. It is distinguished from *A. urens* by the very marked distinction in appearance between the ambulacral and interambulacral abactinal spines; the latter possess constricted connective-tissue sheaths as in all the abactinal spines of *A. urens*, which they also resemble in the possession of well developed poison-sacs, there is, however, very little pigment developed in their sheaths; the ambulacral spines are of equal length to the interambulacral, but have a very thin sheath which is unconstricted, and they are marked by very distinct and regular bands of purple pigment arranged transversely at intervals along the sheath; poison-sacs are also developed on these spines, but their tips are much more fragile than those of the other spines and in process of capture they are nearly always broken. The calycinal system resembles in the adult that of *A. urens* and *A. grubei*, and differs from *A. varium* in the separation of the genital pores from the genital plates, the pore being situated in a V-shaped incision on the outer margin of the plate. The madreporite differs from that of *A. grubei* in being quite flush with the rest of the calycinal system.

The peristomal plates, of which there are ten rows continuous with the ambulacral coronal plates (the interradial plates being

unrepresented in the peristome of *Echinothuridæ*), number in adults normally 9 in one row and 8 in the other row of the pair, although occasionally there may be 8 and 7 respectively. In *A. urens* there are 9 in each row (according to the Sarasins), and in *A. grubei* there are 12. The coronal plates, both ambulacral and interambulacral, are like those described by M. de Loriol for Amboina specimens of *A. varium*, but the ambulacral edge of the narrow interambulacral plates is devoid of tubercles. There are three distinct kinds of pedicellariæ.

Stewart's organs are very well-developed and of the same shape as in *A. urens*, and the muscular partitions are developed to the same extent as in that form.

The alimentary canal does not seem to have been described in detail in any species of the genus, so that I do not know if the condition occurring in this species in universal throughout the genus, or whether it forms a "specific character"; but in addition to the two loops of the alimentary canal occurring in other regular Echinoids (the adoral of the two being connected with the siphon), it makes two additional loops within the former before reaching the "siphonal intestinal loop," these additional loops being situated round the top of the lantern of Aristotle (the siphon appears to be absent).



Radius of *Asthenosoma heteractis* (transverse section).

This section passes *between* the branches to the ambulacral pores, and is thus slightly oblique.

w.v. = radial water-vessel.
b.v. = radial blood-vessel?
r.s. = radial sinus (pseudohæmal canal).
s. = septum between outer and inner radial nerves.
e.n. = epineural canal.
ms. = mesentery formed from the endothelium of the body-wall.
c.e. = endothelium lining body-wall.
c.p. = calcareous plate (decalcified).
c.t. = connective tissue.
i.r.n. = inner radial nerve (ganglion).
o.r.n. = outer radial nerve.

Another character of some morphological interest which does not seem to have been noticed by the Drs. Sarasin in *A. urens*, or

by Agassiz in the 'Challenger' species of the genus, is the condition of the radial water-vessels; these, together with the nerves and associated canals, are slung up from the body-wall by a narrow mesenterial fold, so that the nervous system is farther removed from its primitive epithelial position than, so far as I know, occurs in any other Echinoid (see section figured). The division of the nerve-trunk into a deeper and a superficial layer is very obvious in sections, the deeper layer being swollen at intervals on each side to form ganglia: this condition is quite unique among Echinoids, the deeper nerve-layer being absent in the radii of all forms hitherto investigated in which it is said to be confined to the neighbourhood of the oral ring; its occurrence in the radii of this species recalls the condition in Holothurians.

In addition to adult examples, of which several were taken, two young stages were obtained which I hope to describe in a later communication in some detail, as they show some important differences in the calycinal system, coronal plates, poison-organs, pedicellariæ, &c. I hope also to give a more detailed account of the adult morphology than seemed advisable in a paper dealing chiefly with systematic features.

Adult examples seem to average about 83 mm. in diameter and have a height of about 24 mm.; they are thus smaller than the allied species.

4. Temnopleurus toreumaticus Ag.

Temnopleurus toreumaticus Agassiz & Desor, Ann. Sci. Nat. 3me sér. Zool. t. vi. 1846, p. 360.

References. Alexander Agassiz, Echini, pt. 3, 1873, p. 463.
J. E. Tenison-Woods, Proc. Linn. Soc. N. S. W. vol. iv. p. 159.

Locality. Common between tide-marks and up to 5 fathoms on the east of Singapore island; also common in from 1 to 3 fathoms of water at Tanjong Kling near Malacca, and several young specimens were dredged in 10 to 15 fathoms at C. Rachado.

Habitat. At Singapore they are found on *Zostera* on mud.

Distribution. Reported from the Indo-Pacific area between the Gulf of Persia on the west and New Caledonia on the east; it extends also into North China, and is recorded from N.E. Australia.

The Malacca specimens differ strikingly from those found at Singapore by reason of their much longer spines and somewhat different coloration. In some specimens the general colour-effect is a greenish grey, the spines being light-coloured with 6 to 12 dark transverse bands of the same tint, these bands are conspicuous towards the tip of each spine, but become gradually fainter towards the base; in other individuals the bands are claret-coloured, giving a reddish hue to the entire animal. Individuals do not seem to reach the same size as those recorded from other localities.

Measurements.

	Diam.	Height.	Calyx.	Peristome.	Longest spine.	Locality.	Percentage value D = 100. Longest spine.
1.	24·5	15		8·0	28·5	Malacca	116·3
2.	26	15		7·5	32	„	123·1
3.	34	21		10·0	30	„	88·2
4.	35·5	21·5	8	10·0	33	„	92·9
5.	10·5	7		4	10	Singapore	95·2
6.	34	21		10·0	21	„	61·8
7.	37	21·5	7·5	10·0	21	„	56·8

5. Temnopleurus reynaudi Ag. (?).

Temnopleurus reynaudi, Agassiz & Desor, Ann. Sc. Nat. (3) vi. 1846, p. 360.

References. Alexander Agassiz, Revision of Echini, part 3, 1873. H. Farquhar, Proc. Linn. Soc. N. S. W. xxiii. 1898, p. 318.

Distribution. Ceylon, China Seas, and New Zealand.

Locality. A single specimen only, in 6 fathoms on a bottom composed of sandy mud off the west of Singapore Island, appears to belong to this species.

Diameter 24 mm.; height 13 mm.

6. Salmacis sulcata Ag. (Plate XXII. fig. 3.)

Salmacis sulcata, Agassiz & Desor, Ann. Sc. Nat. (3) vi. 1846, p. 359.

Salmacis globator, Alex. Agassiz (not L. Ag.), Revision of Echini, part 3, p. 473, 1872.

Salmacis alexandri, Bell, Report of Zool. Coll. H.M.S. 'Alert,' 1884, p. 119.

References. J. E. Tenison-Woods, Proc. Linn. Soc. N. S. W. iv. 1878. F. J. Bell, Proc. Zool. Soc. 1880 (*S. globator a*). F. J. Bell, Proc. Linn. Soc. N. S. W. ix. 1885. S. Lovén, Bih. K. Sv. Vet.-Ak. Handl. Bd. 13, Afd. 4, No. 5, 1887. L. Doederlein, Zool. Jahrb., Abth. Syst. Bd. 3, 1888, p. 836. P. M. Duncan & W. P. Sladen, Journ. Linn. Soc., Zool. xxi. 1888. H. Farquhar, Proc. Linn. Soc. N. S. W. xxiii. 1898.

Locality & Habitat, vide *S. globator*, Bell. I believe that this species prefers a somewhat greater depth than *S. globator* (5–10 fathoms), but in any case they are found together in about 5 fathoms. A similar association together of two closely allied species of Echinoids within a limited area occurs in the case of *Echinus esculentus* and *Echinus acutus* at Plymouth (*v.* E. J. Allen, Journ. M. B. A. Plymouth, vol. xv. no. 4, 1889, p. 473). In this latter case the "specific centre" of the two forms appears, from Mr. Allen's

report, to differ considerably in depth, and the area in question appears to represent the shallow-water margin of the distributional area of *E. acutus* which overlaps the centre of distribution of *E. esculentus*.

Two of the specimens collected approach very close to "typical" *S. alexandri* in the more uniform character of their tuberculation, their deeper sutural furrowings, and their general facies; and t seems to me that the two forms represent extremes of a continuous series, the "norm" of which differs in different localities (*cf.* Lovén). Dr. Lovén places this species in the genus *Temnopleurus*, but I cannot see sufficient differences to warrant its generic separation from the other *Salmacis*; the bare median spaces containing the sutural pits, and referred to by Dr. Doederlein, are very obvious in the living animal. The colour of the spines is for the most part dark violet, with the base and tip often cream-coloured (*cf.* Duncan & Sladen).

Measurements.

Diam.	Height.	Calyx.	Peristome.	Percentage values: D=100. H.	C.	P.
50	31	7·5	13·5	62·0	15·0	27·0
59	35	8·0	14·5	59·3	13·6	24·6
61	35	10·5	13·5	57·4	17·2	22·1

7. Salmacis globator Bell (? L. Ag.). (Plate XXII. figs. 4 *a*, *b*.)

Salmacis globator, F. J. Bell, Proc. Zool. Soc. 1880, p. 431 (*S. globator* β).

? *S. sulcatus*, Sladen, Journ. Linn. Soc., Zool. xiv. p. 439, 1879.

References. F. J. Bell, Proc. Linn. Soc. N. S. W. ix. 1885. S. Lovén, Bih. K. Svensk. Vet.-Ak. Handl. Bd. 13, Afd. 4, No. 5, 1887.

Locality. Singapore.

Habitat. The test of this species together with those of *S. sulcata* are frequently found washed ashore on the east side of Singapore Island; unfortunately when collecting I did not recognize that the two species were distinct, so that I do not know in what proportions they occur; they live in considerable abundance from between tide-marks up to about 10 fathoms on a muddy bottom. The synonymy of this, as indeed of all the species of *Salmacis*, is in a state of the greatest confusion. Prof. Bell (*loc. cit.* 1880) described it as *Salmacis globator* (β); some years later (*loc. cit.* 1885) he expressed the opinion that it was identical with Louis Agassiz's *S. globator*, and he then renamed Alex. Agassiz's *S. globator*, *Salmacis alexandri*. Dr. Lovén does not admit that *S. globator* (β) Bell is Louis Agassiz's species, but, on the other hand, unites it with *S. rarispina* of the latter author. It is quite impossible from the meagre description in Agassiz and Desor's 'Catalogue Raisonné' to arrive at any conclusion as to the species they intended; it seems better therefore, for the sake of

clearness, to ignore their definitions in the two cases, and to name it *S. globator* Bell. The species from the Korean Straits described by Mr. Sladen as *S. sulcatus* seems to me to be referable to this form. Owing to the uncertainty of identification of species of this genus, I have omitted their recorded distribution, but it is undoubtedly extensive.

The colour of the spines in the specimens collected was whitish yellow, with irregularly spaced, narrow, transverse purple bands; in one specimen the abactinal spines were all devoid of any purple pigment.

Measurements.

Diam.	Height.	Calyx.	Peristome.	Percentage values: D=100. H.	C.	P.
30·5	20·0	..	8	65·6	..	26·2
53·5	40	9·0	13	74·8	16·8	24·3
58·5	34	10·5	15	58·1	17·5	25·6
75·0	49	..	16	65·3	..	21·3

8. Salmacis rarispina Alex. Agass.

Salmacis rarispina, Alexander Agassiz, Revision of Echini, pt. 3, 1872, p. 475.

References. J. E. Tenison-Woods, Proc. Linn. Soc. N. S. W. vol. iv. 1878, p. 161. P. de Loriol, Rev. Suisse de Zool. t. i. 1893, p. 370.

Locality. Singapore; two specimens dredged in 10 fathoms on sand. The species does not appear to be very common at Singapore, although M. de Loriol mentions having examined several specimens from that locality.

The description given by Mr. Tenison-Woods of individuals from N.E. Australia accords exactly with those in the present collection; and I think there can be very little doubt that they are the same species as Alexander Agassiz's *S. rarispina*; the pale wedge-shaped sutural markings so characteristic of this species are very obvious in both specimens. So far as I can judge, this, as suggested by Lovén, is the *Echinus sphæroides* of Linnæus, but I cannot agree with him in identifying it with *S. globator* (*β*) described by Prof. Bell (P. Z. S. 1880).

Measurements.

	Diam.	Height.	Calyx.	Peristome.	Percentage values: D=100. H.	C.	P.
1....	39	24	7·0	11	61·5	17·9	28·3
2....	54·5	38	..	14·5	68·8	..	26·6

9. Laganum depressum de Blainv. (Plate XXIII. figs. 5 *a–e*.)

Laganum depressum, L. Agassiz, Monograph. d'Échinod. ii. 184, p. 110, tab. 23.

References. Alexander Agassiz, Revision of Echini, pt. 3, 1873,

p. 518. P. de Loriol, Mém. Soc. Phys. &c. de Genève, t. xxviii. no. 8, 1883, p. 37. C. Ph. Sluiter, Natuurk. Tijd. v. Ned. Ind. xlviii. 1889, p. 293. P. de Loriol, Rev. Suisse de Zool. t. i. 1893, p. 375.

Locality & Habitat. Abundant in 5 to 10 fathoms on mud. Singapore.

Distribution. Extends from the East Coast of Africa to Fiji and Kingsmills Is.

Adults are easily distinguished from *L. decagonale* by the shape of the test; the young, however, approach each other rather closely (*v.* figs.); 5 genital pores usually visible.

Measurements.

1.	Length 37 mm.	Diameter 33 mm.
2.	„ 37	„ 33
3.	„ 36·5	„ 31
4.	„ 36	„ 32
5.	„ 36	„ 31·5

10. Laganum decagonale de Blainv. (Plate XXIII. figs. 6 *a–e*.)

Laganum decagonum, L. Agassiz, Monogr. d'Échinod. ii. 1841, p. 112, tab. 23. figs. 16–20.

References. Alexander Agassiz, Revision of Echini, pt. 3, 1873, p. 520. F. J. Bell, Zool. Coll. of H.M.S. 'Alert,' 1884, p. 122. F. J. Bell, Ann. & Mag. Nat. Hist. ser. 5, vol. xi. 1884, p. 130. F. J. Bell, Proc. Zool. Soc. 1894, p. 411.

Locality & Habitat. Very abundant in 3 to 10 fathoms on mud. Singapore and Malacca.

Distribution. Previously recorded from Japan, Prince of Wales' Channel and Thursday Is., New Caledonia, and Bay of Bengal.

The colour, when alive, is a dull red; in spirit this first becomes green, and ultimately disappears more or less completely. As shown in the figures, the test is somewhat variable in shape, the angles of the outline being somewhat less marked in young individuals. The size of the genital openings varies considerably; normally there are four present, although occasionally the posterior pore also occurs: in some specimens the genital openings are quite indistinguishable even in the denuded test; the extent to which the coronal sutures are visible is also extremely variable. This species is placed by Agassiz and others in the subgenus *Peronella*, but Professor Bell (*loc. cit.* 1883) has shown reasons for discontinuing this mode of subdivision of the genus.

Measurements.

1.	Length 66·5 mm.	Diameter 63·5 mm.
2.	„ 57	„ 51
3.	„ 54	„ 49·5

11. Laganum, sp.? (Plate XXIII. figs. 7 *a*, *b*.)

Four small specimens were found among a number of individuals of *Laganum depressum* and *decagonale* which I cannot ascribe to either of these species. It seems possible that they may be hybrid forms. The test is more swollen than in any specimens of either of the two species named; in shape they are quite orbicular and the four genital pores are very large (the posterior being absent): in the two smaller specimens the actinostome and anus are exceptionally large; the internal calcareous connections between the upper and lower surfaces are more complicated than in *L. depressum*, but do not extend to half the distance from the periphery to the centre as in normal *L. decagonale* (*v.* figs.).

12. Arachnoides placenta Agass.

Arachnoides placenta, L. Agassiz, Monogr. d'Échinod. ii. 1841, p. 94.

Reference. Alexander Agassiz, Revision of Echini, pt. 3, 1873, p. 530.

Locality. Singapore, one specimen between tide-marks.

Distribution. Mergui Archipelago, Burma, E. India Is., Australia, and New Zealand.

Transverse diameter 64 mm. Diameter in plane of odd ambulacrum 65 mm.

13. Echinodiscus lævis Agass.

Echinodiscus lævis, Alexander Agassiz, Revision of Echini, pt. 3, 1873, p. 533.

Lobophora truncata, L. Agassiz, Monogr. d'Échinod. ii. 1841, p. 66.

Locality. Singapore, three specimens between tide-marks; at low tide they lie just covered by sand.

Distribution. S. Africa, E. India Is., New Caledonia, China Seas, and Japan.

In one specimen the lunule is incompletely formed on one side, the slit not being closed posteriorly; in the others both lunules are complete.

This species is very closely allied to *E. biforis*, from which it is distinguished by the shape of the test, which is relatively longer in the former, and the transverse line of greatest breadth passes close to the apex, being much more anterior in position than in *E. biforis*; the lunules, also, are shorter. Louis Agassiz's distinction, based on the absence of transverse grooves between the pore-pairs in *L. truncata*, does not hold good; in one specimen the pore-fields on the right side of the odd (ant.) ambulacrum and right posterior ambulacrum are devoid of continuous pore-grooves, while on the other pore-fields they are present; the characters first mentioned are also so variable, that it is quite possible that we are really dealing with a single species[1].

[1] Dr. Hanitsch has sent me an example of this species obtained at Malacca.

Measurements.

Trans. diam.	Other diam.	Distance of anus from post. edge.	Length of lunule on right side.
42	39·5	about 4	6
85	81	6	14
92·5	85·5	5·5	14

14. Lovenia elongata Gray.

Lovenia elongata, J. E. Gray, Catalogue of Echinids in Brit. Mus. i. 1865, p. 45.

References. Alexander Agassiz, Revision of Echini, pt. 3, 1873, p. 575. Alexander Agassiz, 'Challenger' Reports, vol. iii. Echinoidea, 1880, p. 175. R. Koehler, Mém. Soc. Zool. de France, t. viii. 1895.

Locality. A single damaged specimen from 4 fathoms on mud. Singapore.

Distribution. Recorded from the Red Sea and Cape of Good Hope to the Philippines; it extends also into North and West Australia, and according to Agassiz it is found in the Gulf of California.

There is some doubt as to whether this species is correctly determined, on account of the broken condition of the posterior end of the test; but the arrangement of the long serrated abactinal spines and the shape of the actinostome resemble those parts in *L. elongata* more than in *L. subcarinata*, the only species with which it could be confounded: the colour also is characteristic of *L. elongata*, the large spines being yellow banded with violet as in the type.

15. Metalia sternalis Lamarck.

References. Alexander Agassiz, Revision of Echini, pt. 3, 1873, p. 600. P. de Loriol, Mém. Soc. de Phys. &c. de Genève, t. xxviii. p. 44, 1883.

Locality. Pulo Brani, Singapore.

Habitat. This species appears to burrow in fine sand between tide-marks in the same way as *Echinocardium cordatum* on our own coasts.

Distribution. Extends from the Red Sea to Sandwich Is. in the Indo-Pacific circumtropical littoral region; it is also recorded from Australia and New Zealand.

It is at once distinguished from *Brissus carinatus* by its cordiform subanal fasciole, narrower actinal plastron, and deep anterior groove.

Measurements.

Length.	Trans. diam.	Ant. petal.	Post. petal.	Height.	Act. plastron.
71·5	64	24·5	30·5	41	22

16. Brissus carinatus Gmelin.

Brissus carinatus, Gmelin, Linn. Syst. Nat. 1788, p. 3200.

Brissus scillæ, Ag., Agassiz & Desor, Ann. Sc. Nat. sér. 3, Zool. t. viii. 1847, p. 13.

Brissus columbarius, Gray, } J. E. Gray, Catalogue of Echinoidea
Brissus carinatus, Gray, } in Brit. Mus. pt. i. 1855, pp. 53, 54.

Brissus unicolor, Alex. Agass. (not Klein or Leske), Revision of Echini, pp. 97, 357, 598, 1872.

References. N. G. Leske, Addit. ad Kleinii Disp. Echin. 1778, tab. xlviii. figs. 4, 5. F. J. Bell, Proc. Zool. Soc. 1879, p. 349. P. de Loriol, Mém. Soc. de Phys. &c. de Genève, t. xxviii. 1883, p. 47. S. Lovén, Bih. K. Sv. Vet.-Ak. Handl. Bd. 13 (4), 1887, p. 165.

Locality. One denuded test dredged off Pulo Brani, Singapore: there is also another test of this species in the Raffles Museum collected at Singapore.

Distribution. Ranges over the entire circumtropical littoral zone, including the West Indies, Cape Verd Is., Mediterranean, and Indo-Pacific as far east as the Society and Sandwich Islands; it is not recorded from Australia.

M. de Loriol does not agree with Prof. Bell in uniting the *Brissus unicolor* and *carinatus* of Alexander Agassiz into one species; he bases his distinction on characters admittedly variable in different individuals of the same size and in the same individual at different stages of growth. I have therefore, with some hesitation, followed Professor Bell in this respect; but since Dr. Lovén has shown that Klein's *Brissus unicolor* is probably identical with *Metalia maculosa* and certainly not a true *Brissus* at all, it follows that the name of *B. carinatus* should be retained for this species, which is undoubtedly the same as that referred to by Leske as *Spatangus brissus latecarinatus* and renamed *carinatus* by Gmelin. In our example the peripetalous fasciole is normal for Eastern forms, having two re-entering angles in each anterior interambulacram, and in the odd interambulacram it forms a deep angle as in Leske's figure of *Spatangus brissus latecarinatus*. The subanal fasciole is reniform, and there are 5 pedicellar pores on each side of subanal area.

Measurements.

Length.	Trans. diam.	Ant. petal.	Post. petal.	Height.	Act. plastron.
70	52	22	28	39·5	21·5.

II. ASTEROIDEA.

Seventeen species of Asteroids were collected, several of which were, however, represented by single or few individuals; five species were found in the immediate neighbourhood of Malacca, but these were all specifically distinct from any found at Singapore and 3 out of the 5 were very abundant. This is worth noting, since the four species of Echinoids collected at Malacca were common

also at Singapore. The question of the extent to which the same species alters as it migrates from its specific-centre is one the solution of which must lead to a clearer idea of the mode of origin of new species (or rather perhaps new "form-units"). In many cases the same range of variation appears to occur throughout the whole area of distribution of the species, while in other cases we can speak of local varieties or local races; and in such, attempts have been made to trace a gradual progressive modification as we pass outwards from the supposed original "centre." This has been exemplified in some detail by Dr. Döderlein [1] for two species of *Culcita*. In this genus the form and distribution of the pore-areas over the abactinal surface vary considerably within the limits of the same species, and in the two species, *C. schmideliana* and *C. novæ-guineæ*, these pore-areas have a similar independent range of variation from forms with small disconnected areolæ to others in which the areolæ merge into one another, leaving small isolated spaces devoid of pores. *C. schmideliana* var. *ceylonica* and *C. novæ-guineæ* var. *plana* belong to the former type, while *C. schmideliana* var. *africana* and *C. novæ-guineæ* var. *arenosa* belong to the latter type. The distribution of the two species is as follows: *C. schmideliana* occurs in the western part of the Indian Ocean, while *C. novæ-guineæ* extends throughout the Malay Archipelago and Eastern Pacific. Dr. Döderlein points out that at Ceylon var. *ceylonica* occurs, while at Sumatra and Java, the most western points to which *C. novæ-guineæ* extends, var. *plana* is found; and from this he draws the conclusion that "wo die Verbreitungsgrenze beider Arten aneinanderstösst, finden sich Varietäten, die einander auffallend ähneln." From this it would appear that the two species originated from a form intermediate between var. *ceylonica* and var. *plana*, and that the specific-centre of this form would lie between Ceylon and Malaysia. This, however, is at once falsified by finding the opposite extreme of variation, viz. var. *arenosa*, at Singapore, a point nearer to Ceylon than the places at which var. *plana* has been collected. This merely shows how important it is to determine the distribution of varieties before questions of position of specific-centre can be solved, and it will serve, I hope, as an apology for what may be regarded as unnecessary detail in the descriptions I have given of specimens collected. In the case of *Astropecten javanicus* we appear to have a case of progressive modification as we pass from Java through the Straits of Malacca to the Mergui Archipelago, where *A. andersoni*, which I believe to be a variety of *A. javanicus*, is found; but it would be rash to assume this until the region is more fully worked out.

I have adopted in all cases the generic and specific notation employed by Professor Ludwig [2], as it seems to me preferable to attempt to impress some uniform scheme into systematic reports rather than to wage an incessant war of words in defence of doubtful claims to priority.

[1] Semon's Zool. Forsch. in Austr. &c. Bd. v. Lf. 3, 1896, pp. 310–316.
[2] Bronn's Thier-Reich, Bd. ii. Abth. 3, Asteroidea, 1899.

The following is a list of the species represented in the collection:—

1. *Archaster typicus* M. & T.
2. *Craspidaster glauconotus*, sp. nov.
3. *Astropecten javanicus* Ltk., var. *malaccanus* nov.
4. *Astropecten pleiacanthus*, sp. nov.
5. *Luidia longispina* Sladen.
6. *Luidia penangensis* de Lor.
7. *Luidia maculata* M. & T.
8. *Iconaster longimanus* Möb.
9. *Goniodiscus articulatus* de Lor.
10. *Stellaster incei* Gray.
11. *Anthenea flavescens* Perrier.
12. *Pentaceros turritus* M. & T.
13. *Culcita novæ-guineæ*, var. *arenosa* Perrier.
14. *Palmipes rosaceus* M. & T.
15. *Retaster cribrosus* v. Mart.
16. *Patiria*, sp.
17. *Asterina*, sp.

The total absence of *Linckiadæ* from the collection seems worthy of remark.

1. Archaster typicus.

Archaster typicus, Müller & Troschel, Archiv f. Naturg. 1840, p. 323.

References. Müller & Troschel, System der Asteriden, 1842, p. 65, Taf. 5. fig. 2. v. Martens, Archiv f. Naturg. 1866, p. 83. C. Ph. Sluiter, Natuurk. Tijd. v. Ned. Ind. xlviii. 1889, p. 309. P. de Loriol, Rev. Suisse de Zool. t. i. 1893, p. 378. L. Cuenot, Archives de Biologie, xi. 1891, p. 335. H. Ludwig, Bronn's Thier-Reich, Bd. ii. Abth. 3, Asteroidea, 1899.

$$R = 5{\cdot}3 - 7{\cdot}0 \times r.$$

Locality & Habitat. This species was very abundant on a sand-flat just exposed at low tide on Po Senang, Singapore; I did not meet with any examples elsewhere; its habitat appears to be identical on the islets of the Java Sea (*cf.* Sluiter).

Distribution. Extends from the Nicobars and Andamans through the Mergui Archipelago, Malay Archipelago, and N. Australia, as far as the Fiji and Tonga Is. It seems doubtful whether it occurs in Mauritius.

Out of five specimens brought back the superomarginals varied in number from 45 to 50 on each side of interbrachial arch (v. Martens gives 40–45, while Müller & Troschel give 36). There were no traces of superomarginal spines.

In one specimen at the base of one of the arms there is a constriction somewhat similar to that which occurs in *Linckia* before schizogony of the arm takes place; in the present case the

superomarginals meet across the abactinal surface, but the actinal plates are unaffected.

The anus is central, without any tendency towards Cuénot's interradius BC in any of the five specimens brought back: Prof. Ludwig, in his definition of the genus *Archaster*, says, "After central" (*loc. cit.* p. 667); whereas in the body of the work (p. 587) he corroborates Cuénot by stating that it lies "stets mehr oder weniger excentrisch in der Richtung einer interradialen Hauptebene," and he then continues to describe the particular interradius in agreement with Cuénot's notation BC, although he adopts a somewhat different mode of orientation.

Measurements of two extreme individuals:—

No. of marginals.	*R.*	*r.*	Arm-breadth.
46	64	12	13
46	71	10	13

2. CRASPIDASTER GLAUCONOTUS, sp. nov. (Plate XXIV. figs. 8 *a*, *b*.)

References. W. P. Sladen, 'Challenger' Reports, xxx. Asteroidea, 1889. H. Ludwig, Bronn's Thier-Reich, Bd. ii. Abth. 3, Buch 2, 1899. A. E. Verrill, Trans. Connect. Ac. vol. x. pt. 1, 1889, p. 213.

$$R = 5 \times r.$$

Locality. Several specimens from 1 to 3 fathoms, Malacca.

Marginal plates very robust, superomarginals devoid of spines, granular; inferomarginals also granular with a variable number of spinelets; in some specimens there are two complete rows of 3 to 5 spinelets in each row on each plate, the abactinal ones being larger than the rest, but not standing out as a conspicuous fringe as they do in most Astropecten: in other specimens fewer spines are developed, in a few cases only one or two extra spinelets occurring in addition to those on the lateral line; the ventrolaterals also carry each several spinelets; as in *Craspidaster hesperus*, the ventrolaterals are few in number, not extending beyond the fourth inferomarginal. The abactinal surface is paxillose, each paxillus having a circular crown of about eight papillæ, the centre being usually smooth; as in *C. hesperus*, the plates are covered with a membrane which forms a serrated fringe on the edges of the marginals and dorsoventrals; superambulacrals are present between the ambulacrals and inferomarginals; the tube-feet are conical, without any sucking-disc; adambulacral armature is diplacanthid, arching over the furrow is a comb of six subequal spines, outside this on the aboral part of the ventral surface is a single rather stout spine, and on each of the three remaining edges of each plate is a vertical row of 3 to 5 rather short spines. Madreporite is small and circular, situated about halfway from outer edge to centre. In the youngest specimen obtained the spiculation of the ventrolaterals is already developed.

The colour, during life, is bluish green on the abactinal surface, the underside being white (in alcohol the colour rapidly bleaches to a dull grey).

This species is distinguished from *C. hesperus*, the only other known species of the genus, by the spinulation of the inferomarginals and ventrolaterals; the colour is also probably a constant distinguishing feature. As I hope to publish later some morphological details of this species, I will refrain from discussing here the systematic position of the genus, about which there appears to be much divergence of opinion (*cf.* Ludwig, Verrill, &c.).

	R.	*r.*	Arm-breadth.	No. of marginals.
Largest specimen..	75	15	17	47
Smallest „ ..	18	6	6	23

3. ASTROPECTEN JAVANICUS, var. MALACCANUS nov.

Astropecten javanicus, C. Lütken, Vidensk. Meddel. Naturhist. Foren. 1871, p. 234.

Astropecten andersoni, W. P. Sladen, Journ. Linn. Soc., Zool. xxi. 1889, p. 322, pl. 28. figs. 1–4.

Reference. C. Ph. Sluiter, Natuurk. Tijd. Ned. Ind. xlviii. 1889.

$$R = 3{\cdot}3 \times r.$$

Locality & Habitat. Abundant in about 2 fathoms on mud, Malacca: their food seems to consist principally of small Lamellibranchs.

Distribution. Previously recorded from Mergui Archipelago and Java.

This variety is intermediate between the type and *A. andersoni*. It differs from the former in the following particulars:—the lateral spines are always sharp; the adambulacral armature is triplacanthid in adult specimens, the outer series being composed of 2 or 3 small spines forming an oblique arc continuous with the small adoral spine of the middle series. It differs from *A. andersoni* in the spinulation of the inferomarginals, 3 or 4 spines being developed on each plate and forming a transverse row continuous with the lateral spines at the bases of the arms; the paxilli have a circular crown with 8 or 9 spines on the periphery and usually a single central spine. The colour is either chocolate-brown or grey in spirit, as in *A. andersoni*, which seems to me to be a variety of *A. javanicus*.

As in most species of Astropecten, there is a Polian vesicle on each side of the stone-canal and in each of the remaining 4 interradii; each is very long, with a large vesicular extremity, which comes to lie in one of the arms adjacent to the interradius in which the Polian vesicle originates.

R.	*r.*	Arm-breadth.	No. of marginals.
36	11	12	24 or 25

4. Astropecten pleiacanthus, sp. nov. (Plate XXIV. figs. 9 *a*, *b*, *c*.)

Locality. Two specimens in 1 to 3 fathoms on mud on the east side of Singapore Island.

This species belongs to the division of the genus in which there are two series of spines on the superomarginals (Müller & Troschel's classification): the inner series is most strongly developed at the interbrachial angle and only extends a short distance along the arms; while the outer series disappears at their base, as in *A. aurantiacus*, *A. brevispinus*, and some S. American species. The adambulacral armature is triplacanthid; there are three furrow-spines, of which the middle is the longest; outside these on each plate there are two spines, of which the aboral is *much* larger than the adoral; the outer row is irregular, being usually composed of one or two small spines. The marginals are all covered with closely packed scale-like spinelets, the inferomarginals being provided in addition with several larger spines, which are not arranged in a single transverse row, but are situated somewhat irregularly, the abactinal lateral spine being the longest and most robust; paxillar crowns are very large and oval, with about 15 peripheral and 5 or 6 central spines, reminding one of *A. zebra* or *A. polyacanthus*.

This species is undoubtedly very closely allied to the Mediterranean species *A. aurantiacus*; its superomarginal spines are less prominent, the lateral spines are longer and narrower, the paxilli are provided with a larger crown, and the adambulacral armature is slightly different; in many respects also it is extremely like *A. polyacanthus*, from which it is, however, at once distinguished by the presence of bispinose superomarginals.

R.	*r.*	Arm-breadth.	No. of marginals.
51	12	14·5	27–30
32	9	11	24

5. Luidia longispina.

Luidia longispinis, W. P. Sladen, 'Challenger' Reports, xxx. Asteroidea, 1889, p. 254, pls. 43 & 45.

$$R = 5{\cdot}75 \times r.$$

Locality. Two specimens dredged off Singapore in 10–15 fathoms on gravel in association with Gorgonians, &c.

R.	*r.*	Arm-breadth.
23	4	4·5

6. Luidia penangensis.

Luidia penangensis, de Loriol, Mém. Soc. Phys. &c. de Genève, suppl. vol. 1891, p. 25, pl. iii. fig. 2.

Locality. This species is very abundant off Malacca on mud in 2 to 10 fathoms of water, and reaches a much more considerable

size than any of the specimens examined by M. de Loriol. I have found small Lamellibranchs and an entire *Hoplodactyla* in the stomach. I do not remember to have seen any previous mention of Asteroids feeding upon Holothurians.

Distribution. Previously known from Penang.

The specimens appear to agree in all essential details with the original description: the general facies is, however, somewhat different, the arms, which are six in number in all individuals seen (about 30), being longer and narrower in the Malacca form. As M. de Loriol had received as many as fourteen specimens from Penang, this difference seems to be in some way correlated with the locality.

The large pedicellariæ on the adambulacrals mentioned by de Loriol as present in some cases appear to be constant in our specimens, and the anatomical details are subject to very little variation. Contrary to the general rule in long-armed starfish, the arms had not undergone regeneration in any of the specimens.

It is a striking fact that this species was not met with at Singapore, where an apparently similar habitat is available.

R.	*r.*	Arm-breadth.
125	21	
117	15	17
72	11	
51	10	11

At Professor Bell's request, M. de Loriol kindly sent two of his original dried specimens for comparison: these were much smaller than the average of our examples, but they seem to be similar in all essential respects, although, on account of the condition of M. de Loriol's specimens, it was impossible to carry out a very detailed investigation.

7. Luidia maculata.

Luidia maculata, Müller & Troschel, Syst. d. Ast. 1842, p. 77.

$$R = 7{\cdot}6 \times r.$$

Locality. A single large 7-armed specimen from between tide-marks, Singapore. The arms had undergone a considerable amount of fracture and regeneration.

Distribution. Extends from Mozambique to Macclesfield Bank and northwards to South Japan.

R.	*r.*	Arm-breadth.
190	25	23

8. Iconaster longimanus.

Astrogonium longimanum, K. Möbius, Neue Seesterne d. Hamb. u. Kiel. Mus. 1859, p. 7, Taf. i.

Dorigona longimana, F. J. Bell, Zool. Coll. of H.M.S. 'Alert,' p. 130, 1884.

References. J. O. E. Perrier, Révision des Stellérides, 1875, p. 229. Th. Studer, Abhandl. Akad. Wiss. Berlin, 1884. L. Doederlein, Semon's Zool. Forsch. in Austr. &c. Bd. v. Lf. 3, p. 31, Taf. xviii. fig. 3.

Locality. A single specimen dredged in 10 fathoms off Malacca.

Distribution. Malacca to Australia.

A single specimen was brought to Europe in 1837 from the Straits of Malacca by Eydoux and Souleyet (*v.* Perrier), but the authenticity of the locality has been since doubted; it is interesting therefore to have the opportunity of confirming the original statement.

This specimen appears to be identical with Australian examples in the British Museum; a minute, scanty granulation is present on the superomarginals, the inferomarginals being smooth; in three of the arms the superomarginals of each side alternate along the arm, especially towards its distal end (*cf.* Doederlein's figure and also Studer's *Dorigona moebii*).

R.	*r.*	Arm-breadth.	No. of marginals.
52·5	15	17 5	21

9. Goniodiscus articulatus.

Pentaceros granulosus, J. E. Gray, Synopsis of Starfish, p. 6, tab. 6. f. iii. (1866).

Goniodiscus scaber, K. Möbius, Neue Seesterne d. Hamb. u. Kiel. Mus. 1859, p. 10, Taf. iii.

Goniodiscus articulatus (Linn.), P. de Loriol, Rec. Zool. Suisse, t. i. 1884, p. 638, Taf. xxxv.

References. W. P. Sladen, Journ. Linn. Soc., Zool. xxi. 1888, p. 328. R. Koehler, Mém. Soc. Zool. France, viii. 1895 p. 392.

$$R = 2{\cdot}2 \times r.$$

Locality. Four specimens in 5 to 10 fathoms, Singapore (two are quite young).

Distribution Mergui, Singapore, Sunda Straits; Swan River and Fremantle, W. Australia. The species appears to be rare.

I can find no distinction between *Pentaceros granulosus* and this species.

R.	*r.*	Arm-breadth.	No. of marginals.
70·5	32	38	14–15.

10. Stellaster incei.

Stellaster gracilis, K. Möbius, Neue Seesterne d. Hamb. u. Kiel. Mus. 1859, p. 12, Taf. i. figs. 3, 4.

Stellaster incei, J. E. Gray, Synopsis of Starfish in Brit. Mus. p. 7, 1866.

Stellaster belcheri, J. E. Gray, Synopsis of Starfish in Brit. Mus. p. 7, 1866.

Stellaster squamulosus, Th. Studer, Abhandl. Akad. Wiss. Berlin, 1884 iv. p. 33, Taf. iv. fig. 6.

References. L. Doederlein, Semon's Zool. Forsch. in Austr. &c. Bd. v. Lf. 3, 1896, p. 337. L. Doederlein, Semon's Zool. Forsch. in Austr. &c. Bd. v. Lf. 4, 1898.

Locality. This is perhaps the commonest Starfish in the district; it lives in 3 to 10 fathoms on mud or shelly gravel, Singapore. I found a specimen infested by two individuals of a species of *Thyca*, they were fixed close together on the abactinal side.

Distribution. Singapore to Australia, extends northwards to the Korean Straits.

		R.	*r.*	No. of marginals.	No. of tubercles :		No. of pigment-spots.
					rad.	interrad.	
1 ...	alc.	36·5	15·5	13	12	1	? (dissolved).
2 ...	„	29	10·5	13	3	0	? „
3 ...	„	21	8	12	5	0	? „
4 ...	„	14	5	9	0	0	? „
5 ...	„	12·5	4·5	9	0	0	? „
6 ...	formol	56	24	16	24	0	73
7 ...	„	55	23	15	?	?	21
8 ...	„	45	17	15	5	?	22+several small.
9 ...	„	41	16	15	?	?	53
10 ...	„	38	14	15	5	0	27
11 ...	„	36	14	13	10	0	21
12 ...	„	27	10	13	11	1	23

Black pigment is developed on a variable number of the ventro-lateral plates; this completely disappears in alcohol specimens, but is preserved with formol; there seem to be only a few cases in which the underside of starfish is pigmented; as in the case of the black pigment often found lining the body-cavity of Holothurians, its use is not in the least known.

11. Anthenea flavescens.

Hosea flavescens (part), J. E. Gray, Synopsis of Starfish, p. 9, 1866.

Anthenea flavescens, J. O. E. Perrier, Révision des Stellérides du Mus. de Paris, 1875, p. 276.

Locality. A single young specimen which appears to belong to this species was dredged between 5 and 10 fathoms off Tanjong Kling, Malacca.

Distribution. Previously recorded from Port Jackson and W. Australia.

R.	*r.*	Arm-breadth.	No. of marginals.
14	7·5	9	9

12. Pentaceros turritus.

Oreaster turritus, Müller & Troschel, System der Asteriden, 1842, p. 47.

Oreaster nodulosus, F. J. Bell, Proc. Zool. Soc. 1884, p. 66.
Reference. v. Martens, Archiv für Naturg. 1866, p. 77.

Locality. This species is found not uncommonly in about a fathom of water on the shore of the lagoon off the east side of Singapore Island.

Distribution. Indian Ocean, Eastern Archipelago, and N. Australia.

The systematic classification of the genus *Pentaceros* offers similar difficulties to those found in the Echinoid *Diadema*; in both cases we have exceedingly variable groups of individuals in which the norm of the variations is different in different localities. The four "species" *Pentaceros turritus* M. & T., *P. hiulcus* M. & T., *P. muricatus* Gray, and *P. alveolatus* Perrier, which Professor Bell describes as "apparently distinct," are based on characters which are admittedly subject to very great variation; and while Prof. Bell instances the presence or absence of marginal spines as a character by which "we can always safely discriminate between *O. lincki* (=*P. muricatus*) and *O. nodosus* (=*P. turritus*)" (*loc. cit.* p. 59), at the same time Dr. Martens had named two varieties of *P. muricatus* (var. *mutica* and var. *intermedia*) in which the marginal spines completely fail: this of course is entirely due to the fact that no two observers are agreed as to the best set of characters to select for specific diagnoses, and in consequence a totally different grouping of the same series of specimens would be resorted to by different systematists. Whether it is advisable in such a case to unite all the forms under one specific name, as has been suggested for the Pacific Diademas by Prof. Lovén, I do not feel in the least competent to express an opinion.

Specimens both with and without a central apical tubercle occur at Singapore as elsewhere, and in the former case the apical tubercles may be much longer and sharper than in the latter, in which they are usually mamilliform; I do not know if individuals with the marginal spines developed occur in the locality.

Two specimens gave the following measurements:—

R (act. side) = 116 mm., *r* = 46; arm-breadth = 54; no. of marg. plates = 23; 9 lophial tubercles, 3 or 4 interradials.

R (act. side) = 128 mm., *r* = 52; arm-breadth = 58; no. of marg. plates = 27; 7 or 8 lophial tubercles, 4 interradials.

13. Culcita novæ-guineæ, var. arenosa.

Culcita novæ-guineæ, Müller & Troschel, Syst. d. Ast. 1842, p. 38.
Culcita arenosa, J. O. E. Perrier, Révision des Stellérides, 1875, p. 264.
References. C. Ph. Sluiter, Natuurk. Tijd. v. Ned. Ind. xlviii. 1889, p. 305 (*C. schmideliana*). Cl. Hartlaub, Notes from the Leyden Museum, xiv. 1892, p. 65. R. Koehler, Mém. Soc. Zool. France, viii. 1895, p. 388. L. Doederlein, Semon's Zool. Forsch. in Austr. &c. Bd. v. Lf. 3, 1896.

Locality. This species is fairly common on Pulo Reugkam Singapore, between tide-marks on the reef; it lives in company with, and appears to have a mode of life similar to, the large tropical species of *Muelleria*.

Distribution. This variety has previously been recorded from Amboina, Ceram Laut, and the Sandwich Islands.

Unfortunately I have only examined one specimen with care, so that I do not know whether the other recorded varieties of the species also occur in the district. This specimen must certainly be regarded as the *C. arenosa* of Perrier: the pore-areas are not distinct from each other but tend to unite over the whole abactinal surface, leaving small, distinct islands which are devoid of pores and granular, the larger of these spaces being about the same size as the madreporite; they are devoid of large spines, thus differing from typical *arenosa* and approaching *C. coriacea* M. & T. The madreporite is an irregular oval structure, and is quite prominent, being bordered with a few large blunt spines; it measures 13 mm. × 6·5 mm.

Dr. Doederlein has shown that *C. novæ-guineæ* differs from the Western species *C. schmideliana* in the character of granulation of the ventrolaterals, the larger granules not being divided up into distinct groups corresponding to the subjacent plates in the former. In the specimen now described this holds good, and parallel to the ambulacral furrow up to within a distance of about 7 mm. from it the granules enlarge gradually up to the furrow, where they form a conspicuous edging: in the adambulacral armature there are 3 to 6 furrow-spines (usually 5) on each plate, the outer row being extremely irregular and poorly developed, over a large part of the arms it seems to disappear completely.

Dr. Sluiter has pointed out how impossible it is in this genus to rely on shape for specific diagnosis; and in this species, at any rate, this character depends almost entirely on the mode of preservation. During life, especially when left dry on the reef at low-tide, the outline may alter considerably, and, if placed on a flat surface with the actinal side downwards, the upper side would flatten out over the edge, so that the ambulacral furrow would appear confined to the lower side (*cf. C. acutispinosa* Bell); also when specimens are placed in a basin and spirit is poured over them, the lower surface (abactinal or actinal) will often accommodate itself to the shape of the bottom of the vessel.

$$R + r = 195 \text{ mm.}$$

14. PALMIPES ROSACEUS.

Asteriscus rosaceus, Müller & Troschel, System d. Ast. 1842, p. 40

Distribution. Japan and Bay of Bengal.

Locality. One large and rather damaged specimen in 5 fathoms, Singapore.

This species, being the only 15-armed Asterinid, is easy to recognize; it appears to be rare.

$$R = 121{\cdot}5 \text{ mm.}, \; r = 82 \text{ mm.}$$

15. Retaster cribrosus.

Pteraster cribrosus, von Martens, Arch. f. Naturg. 1867, p. 109, Taf. iii. fig. 2.

Retaster insignis, W. P. Sladen, 'Challenger' Reports, vol. xxx. Asteroidea, 1889, p. 482.

References. M. Sars, Öfv. af Norg. Ech. Christiania, 1861, tab. 4. J. O. E. Perrier, Révision des Stellérides, 1875, p. 383. L. Doederlein, Semon's Zool. Forsch. in Austr. &c. Bd. v. Lf. 3, 1896, p. 319.

Locality. Four specimens, two of which are quite young, in 10–15 fathoms, Singapore.

Distribution. Zanzibar, Mozambique, Ceylon, Philippines, Amboina, Samoa (*Doederlein*).

The largest specimen agrees with Dr. Doederlein's description of a specimen from Amboina. The colour, when alive, of all four specimens was bright brick-red, but they rapidly become colourless in spirit; when alive, the osculum can be seen to open and close with a fairly regular rhythm of about once every ten seconds. Sars has given an account in *Pteraster militaris* of the osculum bounded by five lappets and of the cavity into which it leads, situated between the dorsal membrane and the true abactinal surface of the body, and in direct communication with the exterior by a large number of short straight tubes in the former and lined by a columnar epithelium; it appears to function in both sexes as a respiratory chamber, and secondarily in the females as a brood-pouch; but my want of knowledge of Norwegian has prevented me from understanding Sars's paper as much as I should have wished, but the relations appear to be the same in this species. The reticular arrangement of muscle-fibres in the dorsal membrane is only apparent under a microscopical examination.

In addition to these 15 species there were two species of *Asterinidæ*, each represented by a single specimen. I cannot identify them as belonging to any known species; but as they both appear to be young forms, it seems advisable to defer description until a later date, when a fuller series may be obtainable: they belong to the genera *Patiria* and *Asterina* respectively.

EXPLANATION OF THE PLATES.

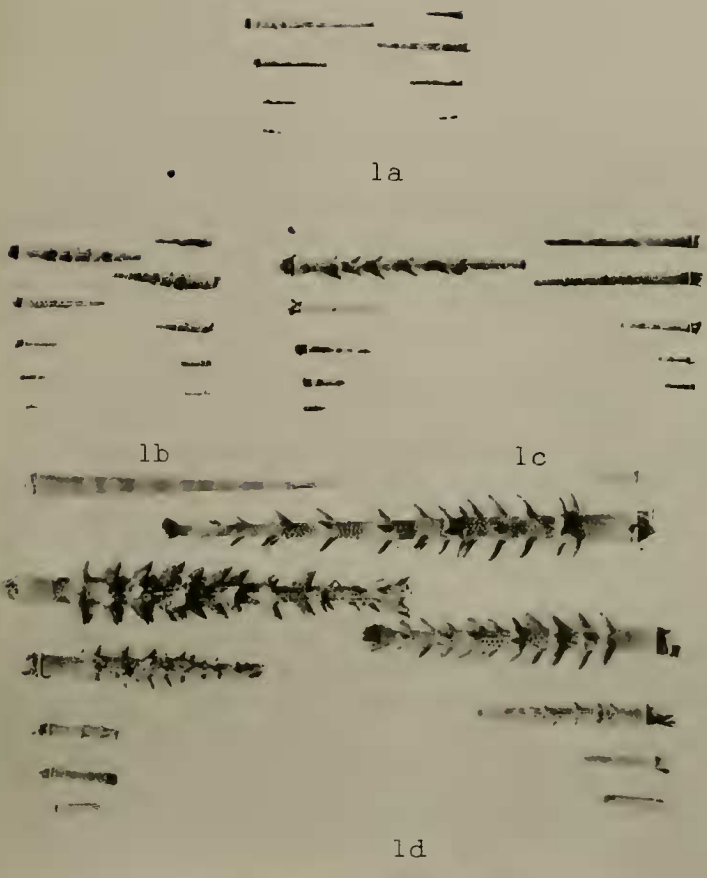
Plate XXI.

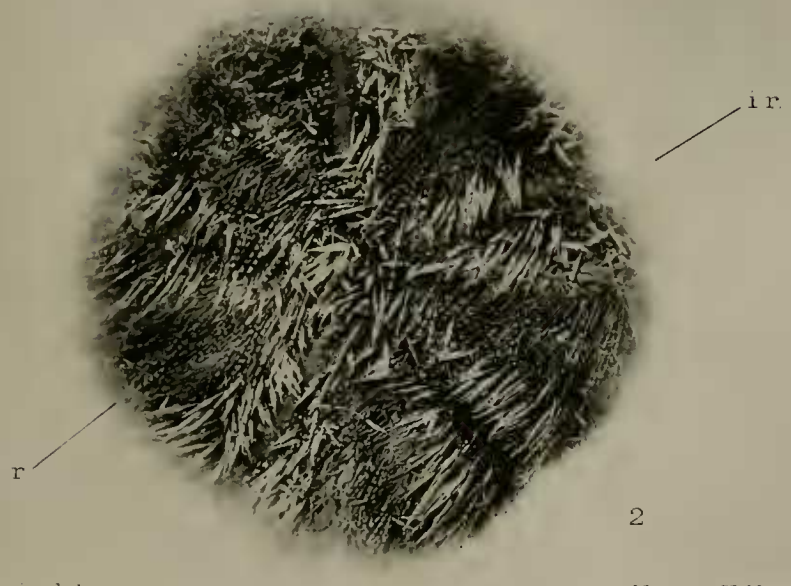
Fig. 1. *Rhabdocidaris annulifera*, p. 274.

a. Spines from an interambulacrum of specimen No. 1. Nat. size.
b. ,, ,, ,, No. 2. Nat. size.
c. ,, ,, ,, No. 4. Nat. size.
d. ,, ,, ,, No. 6. Nat. size.

(*Vide* table of measurements in text, p. 276.)

The spines are so arranged that the uppermost in each series is that which lies nearest to the calycinal system of the test, the lowermost being that which borders on the actinostome; they are also laid flat, so that their bases lie next to the adjacent ambulacrum, their points being directed towards the centre of the interambulacrum; no attempt has been made

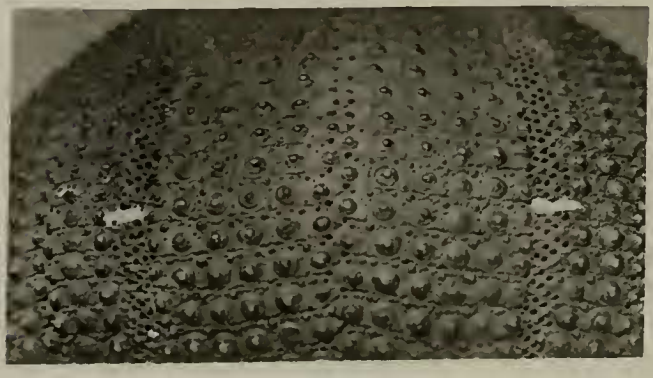




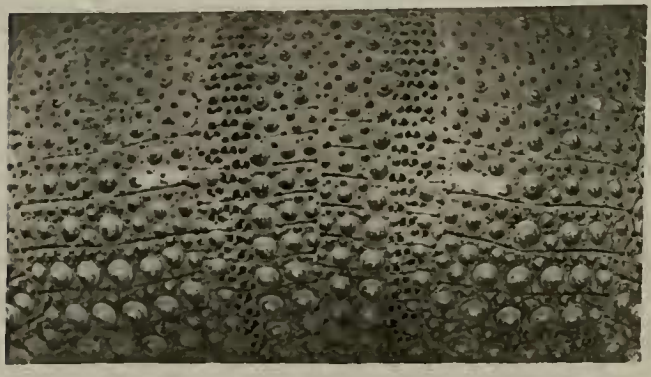
G T Harris phot. Morgan & Kidd, collot

ECHINODERMS FROM SINGAPORE AND MALACCA

3a



3b



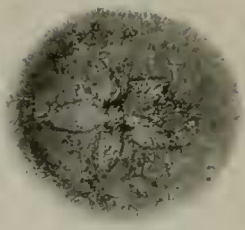
4a

4b

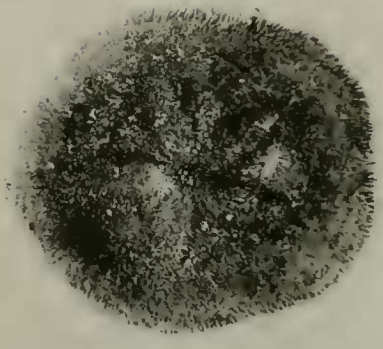
G T Harris, phot. Morgan & Kidd, collot

ECHINODERMS FROM SINGAPORE AND MALACCA

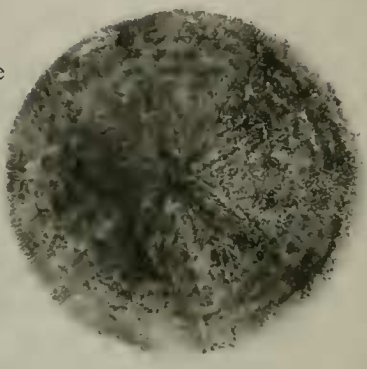
7a



7 b



5 e

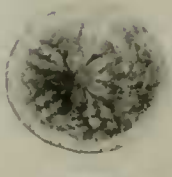


6 e

5 d

6 d

5 c



6 c.

5 b

6 b

5a

6 a

G T Harris, phot

Morgan & Kidd, collot

ECHINODERMS FROM SINGAPORE AND MALACCA